



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

taken place, and it has not been as great on the islands as on the adjoining continent. There remains at least one fact to be determined, and for its acceptance additional research is certainly necessary. The flora of the Santa Barbara Islands is said to differ essentially from that which at present exists on the neighboring main-land of California. What is the relation of the present flora of California to that of the Santa Barbara Islands, and what was the flora of the main-land, especially in the Pliocene Age? Has there been an intercolonization of islands and continents since that glacial period? These are questions to be answered, but the most important one of all is, "Are any of the plants of the islands peculiar to them?" The above paper accepts the observations of others that they are. It seeks to point out a cause more potent than any yet suggested, to account for peculiarities of this insular flora if such peculiarities exist.

THE TEETH AS EVIDENCE OF EVOLUTION.

W. C. CAHALL.

IN the August number of *Lippincott's Magazine* appeared a paper by W. G. A. Bonwill, entitled "Why I Deny Evolution." The argument is based upon the structure of the teeth and their relation to the human jaw.

It would be as incomplete to confine your argument in support of the law of gravitation to a single phenomenon, *e. g.*, shooting stars, as to rest your plea for evolution upon the human jaw. It is manifestly unjust to the proper appreciation of a great doctrine like Evolution to deliberately deny oneself the great wealth of evidence furnished by Geology, Embryology, Rudimentary Organs, and the Comparative Anatomy of the several organs of the animal economy; yet it would be equally unfair to Dr. Bonwill to meet his argument upon any other ground than that upon which his argument is based, the human jaw.

At the same time the law of gravity, if a true one, ought to explain the phenomena of shooting stars, although it might fail to convey a proper conception of its grandeur and universality; so should evolution afford a full explanation of the complexity and adaptability of the teeth and jaw, and this I firmly believe can be readily done.

Before we proceed with a presentation of the other side of the question, it might be well to offer a few good-natured criticisms of Dr. Bonwill's definitions and claims.

I take issue with his very first sentence, "It must be creation or evolution—creation by some personality placing a perfect organic being at one master-stroke into life and action; or by some impersonality, from the lowest point of life, by slow development reaching higher and higher in the scale of being until man has been reached."

I deny that such a view of evolution is the only one which can be entertained. That the evolution of life upon this planet was the outcome of an impersonal nature, acting by forces strictly physical and without a directing mind, is the belief held by the materialistic school exclusively. To classify all evolutionists as materialists would do the greatest injustice to many of the most eminent scientists in this country and Europe. These men see nothing inconsistent in the belief in evolution as a method by which a personal Creator accomplished his ends, and the account of Moses.

The late Dr. Asa Gray, of Cambridge, accepted as authority throughout the whole scientific world to a degree perhaps never attained by any other American, voices this school when he says: "I am scientifically—and in my own fashion—a Darwinian; philosophically, a convinced theist; and religiously, an acceptor of the creed 'commonly called the Nicene,' as the exponent of the Christian faith."

So when Dr. Bonwill declares: "It must be creation or evolution," he could more correctly have written: "It must be creation *by* evolution." This is theistic evolution.

I also take exception to the loose and unscientific manner with which Dr. Bonwill uses "organs" and "organisms" as words of

synonymous or identical meaning. Nothing is farther from the truth. These words have as distinctive and individual a meaning as any words in scientific usage, conveying totally different ideas. An *organ* is a part of a body capable of performing some especial work, while an *organism* is the whole body, a unit or entity, which the various organs in their mutual relationship compose. That this is not my definition, devised for a purpose, the nearest scientific dictionary will confirm. Ordinarily the misuse of scientific language might result from an oversight and be of little or no importance, but here it is not so, for Dr. Bonwill's leading argument stands or falls with this definition. We will assume that the question which he quotes from Mr. Darwin to be correct: "*Demonstrate* to me a complex organism that can be made in any other way than as I say, by slow, slight modifications, and my argument falls to the ground." To this query of Darwin's he replies: "I have duplicated by design and intelligence the most complex organ in the human body, and made it perform the same function as the natural organ." The organ he refers to here is a set of teeth. There is no evidence here but of entire satisfaction that when he has made a set of teeth, or a "complex organ" as he calls it, he has met the demand of Darwin for a "complex organism." If the words "organ" and "organism" are not identical in meaning to Dr. Bonwill's mind, why does he upon the same page as the above use such language as this: "I claim to have made a demonstration of the construction of a complex organism—the human teeth—according to these laws; a demonstration which accounts for all the functions of the natural organism." "I claim that if I am able to form such a complex organism by a single act of creation, I must be greater than nature, or must have anticipated her by millions of years." "I claim that this organism could not have been made from that in any other existing type of animal or combination of animals." Dr. Bonwill promises to put in book form these arguments. It will be well, before he fulfils this promise, that he should learn that a *complex organism* is something more than an artificial set of teeth.

He claims, and he puts it in italics, "*I claim to have discovered that the lower jaw of man is an equilateral triangle, and that all races have it, and that it has so existed from the advent of the first man.*" Also, "that it belongs exclusively to man." He claims that as an equilateral triangle in a hexagon is the equal of a circle, and as a circle is the embodiment of perfection of form, it is a natural deduction that the human jaw cannot be evolved higher or a more perfect form conceived. Such is the discovery which he has made and which he classes with the law of gravitation, a claim, to say the least, which cannot be characterized as modest.

I will give his own words: "I claim that as Newton discovered that geometry and mechanics governed the formation and action of the astronomical worlds, I have an equal right to the discovery of the relation of the same laws to the structural organic world."

If the human jaw be the perfect instrument claimed for it, and beyond the reach of further evolution, this would not, as he holds, prevent the contrary hypothesis; that it is the end towards which nature has tended by evolution through successive forms of life, from the simpler to the more complex.

That the human jaw is an equilateral triangle is an interesting anatomical observation, and Dr. Bonwill, if he is the first to notice it, should have all credit for discovering the fact; and that the teeth are perfect in position and adaptability to their intended purpose, goes without saying. But to stop to even enumerate all the observations bearing upon the relation of the various organs to the principles of geometry and mechanics would tire the reader, and the evolutionist of all people would be the last to deny the perfect adaptability of the organs to their destined use, for it is this they bring in evidence as to the truth of evolution.

The intimate relation of the eye to optics, of the ear to acoustics, of the lungs to pneumatics, of the heart to hydraulics, of the digestive organs to chemistry, and the attachments of muscles to bones to the physics of levers, are familiar to every student of anatomy and physiology.

To discover that the human jaw and teeth are so perfect an instrument that human ingenuity cannot conceive of any improvement, but must crudely imitate the pattern nature furnishes when artificial assistance is needed, is no exception; is it not the same with the human eye, the ear, the hand, the foot? A manufacturer of artificial legs might with equal justice claim that he has discovered that the line of junction of the human foot to the leg was a right angle; that all races have it, and that it has so existed from the advent of the first man; that it belongs exclusively to man; that a right angle is the quarter of a perfect circle, and the only angle which will equally divide both a circle and a half circle; that consequently the human foot was a special creation, and could not have been evolved from something lower, and could not have been evolved into something higher; that he had made an artificial leg, which performed all the functions of the natural one, even to the complex movements of the ankle-joint, so perfectly as to deceive all beholders; that—*ad infinitum et ad*——

Is it not already evident that such a line of reasoning may lead one to the most absurd conclusions?

There is one other question which has no direct bearing upon the argument from the teeth, but which I notice because Dr. Bonwill makes so much of it. He claims that since according to the first law of motion a body once set in motion will continue to move in a straight line forever unless deflected by surrounding bodies, and made to describe an orbit; and as no world ever did go in a straight line, but began at once to move in a circle or ellipse, "it is plain that it never began the universe by making one world at a time and throwing it into space, it being absolutely necessary that there should be at least three worlds in order to counterbalance each other, and make the first law of motion a fact."

There are some arguments which, like a two-edged sword, cut both ways. If such a condition of things be true, I would like an explanation of the first chapter of Genesis, which both Dr. Bonwill and I believe, where we are told that the Lord created the earth, gave it globular form, made dry land appear, and vegetation grow, for *three days before* the sun, moon and stars were called forth.

He further says, "I claim that as all organic life has such a struggle for existence, and as nature has to be always on the alert to select, that it is as much as an organ or an organism can do to keep itself up to the standard of healthy action; that *death to the weakest* is rather the rule than "survival of the fittest."

Has not the Doctor here given away his whole case? What is the "survival of the fittest," if it is not by the *death of the weakest*.

Evolution as a process of nature is not the hasty generalization of a single science; rather a greater part of all the sciences have become but widely different yet converging avenues of approach, along which the student travels naturally to the central hypothesis, which has now become the dominant factor in all scientific investigations. It lies at the foundation of the new astronomy of the sidereal and solar systems; geological study of the strata furnishes indubitable evidence of the appearance upon the earth of forms of life of the simplest nature, succeeded by forms of constantly-increasing complexity; comparative anatomy teaches how from the three elementary layers of the blastodermal cells every tissue and organ of every animal is developed along identical lines; comparative botany tells the story; embryology, under the microscope, is daily showing that every highly-organized being is passing through that identical evolution of structure from the simple to the complex which the special creationists deny to nature at large; rudimentary organs are so many interrogation marks, unanswerable on any other ground than that of evolution; sociology is carrying the question into the study of government of the human kind collectively; and the first chapter of Genesis, when read in the light of the evolution hypothesis, reveals a sublimity of conception and accuracy of description never before realized. Testimonies so different, yet confirming each other, appeal with a force like the result of an algebraic problem, which, when tested and confirmed by several different methods, possess an accumulative proof of geometrical rather than numerical ratio. But in our present view of the question the accumulative evidence is lost, for we are confined to a single line of inquiry.

The order of the Vertebrates, as classified by zoologists, accord with the order of succession as found by geology, and are divided into five great sub-divisions, viz: Fishes, Amphibians, Reptiles, Birds, and Mammals.

Only in the vertebrates do we find calcified teeth. In the fishes, some of the lower orders have teeth only partially calcified; which, in fact, appear simply as horny excrescences upon the mucous covering of the mouth. Even teeth such as these did not, like Minerva from the brow of Jove, spring into being, full-formed. If it were found that the teeth, or any other organ, appeared fully-formed, and suddenly, serious objections might then be made against evolution. Nature takes no leaps, but everywhere, in everything, takes some tissue, already existing, and by slight modifications transforms it into some complex organ. So we find that even the simple teeth of the fishes can be traced back to simpler structures in the Invertebrates. Upon the approximating folds of the radiate-shaped mouth of the sea-stars are hardened papillæ and spicules which function as *masticating organs*.

Coming higher in the scale we find the mouths of the Crustacea provided with a firm chitinous framework, with ridges, spicules or setæ forming tooth-like processes opposite each other and moved by muscles. These serve as an efficient apparatus for the comminution of food and are called the *masticatory stomach*.

Among the Mollusca, the mouths of several varieties are provided with jaws, covered with a cuticular membrane, on which are small teeth or hooks directed backward. When this membrane is protruded these teeth are erected, and when drawn back they come together like pincers and hold the prey.

The comparative anatomy and gradation of teeth may be seen by the table on page 232.

Evidence from Paleontology.—The diversity of size, structure and specialized function of the teeth of the Mammalian family are directly traceable to the mode of obtaining food.

The constant use of one variety of food has so developed one portion of the teeth, and atrophied, through disuse, the other portion, that the mouths of the existing families of the Mammalia

present teeth of quite contrasting appearance. Yet the ancestors of the animals whose teeth now so clearly separate them into the piscivorous, carnivorous, insectivorous, herbivorous and omnivorous families, did not so widely diverge. The early Tertiary mammals, whether they were herbivorous or carnivorous, possessed the full number of forty-four teeth, which appears to have been the typical number. While the present adult cud-chewing animals no longer possess the incisors and canines in the upper jaw, those ancient ruminating mammals, the Dicobune, Dichodon, and Anoplotherium, had incisors and canines in both upper and lower jaws.

The elephant has the incisors of the lower jaw absent, the premolars absent, the true molars united into compound organs of great complexity, and the upper incisors developed into tusks, while its great prototype, the Dinotherium, possessed permanent premolars in both jaws, the true molars simple, and had the incisors in the lower jaw. Another example is found in the bear of the present, which has the third true molar absent, while its ancestor, the Amphycyon, has the entire set intact.

Evidence from Embryology and Rudimentary Organs.—Prof. Goodsir has discovered that in the embryos of the modern ruminating mammals, calves, for instance, the rudiments of the canines and of the incisors of the upper jaw appear, but do not pass beyond the rudimentary stage after birth.

An organ which is not in use atrophies, and an animal which has no use for certain teeth loses them. Nature conserves, but wastes not.

The organs may be preserved in the embryos, because the embryo passes through all the stages through which the species passed in its evolution.

In the whalebone whales there are varieties which have the full set of teeth germs to form during fetal life, and even to calcify, but become completely absorbed before birth; in others, where some of the teeth remain in the jaw, they are covered up by the gum during the entire life of the animal; in others still, the teeth of the upper jaw alone are rudimentary and functionless, being imbedded in the gum.

VERTEBRATES.

FISHES.	AMPHIBIANS.	REPTILES.	BIRDS.	MAMMALS.
1. Teeth grading from erect horny spicules up to calcareous. 2. Teeth arranged in rows, two or three in number, and are situated not only upon the jaws, but also in the ganoids for instance, upon the palatines, vomer, parasphenoid, and onlyoid and branchial arches. 3. In some fishes the teeth are fixed in the buccal membrane without support by underlying cartilage and bone, and partly movable; in others, when united to the bone, it is usually through ossification of the bone to the tooth, very rarely a process of bone projects into the tooth.	1. Teeth usually calcareous. 2. Teeth also found upon palatine and vomer, but rarely on the parasphenoid.	1. Teeth always calcareous. 2. Among Reptilia, the Ophidia and Sauria alone have teeth on the palatine and pterygoid, while the Crocodilia have teeth only upon the maxillary bone.	2. The Birds have no teeth, but since there are fossil forms which possess them, and since the embryos of some present birds show teeth in rudimentary form, it is evident that the teeth have been lost to those now extant simply through non-use.	1. Teeth always calcareous. 2. The teeth of Mammals are confined to maxillary bones. 3. The teeth are <i>entirely</i> fixed in the alveoli.

4. Teeth are in great numbers; in single, double, or triple series, and are constantly being shed and renewed throughout life. In the shark's mouth may be seen a row of teeth, when broken or worn away, replaced by a second row either just in front or behind the first, which in turn is replaced by the third, and so on indefinitely.

5. Since the teeth of fishes are for seizing of prey and not for masticating it, their usual form is conical and inclined backward.

6. The lower jaw is of cartilage and attached to the skull by a loose cartilaginous ligament, which allows only an up and down motion.

4. In the Amphibia and Reptilia there is a prodigal renewal of the teeth, though not to the extent which obtains in the fishes.

5. For the same reason the teeth of Amphibia and Reptilia are likewise conical and bent backward. There is one exception in the Lizard family, where the teeth are differentiated and thus approach the classification common among the mammalia.

6. Among the Amphibia and Reptilia the lower jaw (sometimes bony and sometimes partly cartilaginous) is attached to the skull loosely through an intermediate bone, the tympanic bone, which allows an extraordinary separation of the jaws, as in snakes when swallowing their prey, but which precludes the chewing of food and which allows only the simple vertical motion of the jaw.

4. Mammals have but two sets of teeth, the milk and the permanent set.

5. The teeth, with few exceptions, are differentiated into the incisors, canine and molars, one or the other of these predominating as the mammal's habit of feeding has modified them.

6. The lower jaw of all mammals articulates directly to the skull, but there is great diversity of motion of the jaw in the Mammalia. In those of carnivorous habit, whose food and mode of eating are similar to the fish and reptiles, there is the simple hinged motion in a vertical plane; in the herbivorous animals, whose food requires to be ground before swallowing, have developed a lateral, sliding motion of the molars one upon the other; while in the omnivorous, both of these motions are preserved.

In the embryos of some birds the rudiments of teeth are distinctly traceable, yet in no class of birds extant do the teeth pass beyond this rudimentary stage. How can these rudimentary organs be explained by believers in special creations? Surely not, as is usually explained, "in order to complete the scheme of nature" or "for the sake of symmetry," for if these be the reasons, why do not the rudimentary teeth appear in the embryos of all birds, of turtles, and of some ant-eaters, where they are not present at any age? On the other hand, how clear the question becomes in the light of evolution by natural selection! As Darwin has so aptly put it; "The unity of type is explained by unity of descent."

Nor can rudimentary organs be explained by assuming them of some use to the animals. On the contrary there are some of positive harm to the possessor. Confined to the teeth as we are by the present discussion, we can still find an instance here, and in no less an animal than man himself. There are in the upper jaw two small premaxillary bones which in the lower animals remain distinct and separate throughout life, but in man early become fused with the larger maxillary bones. It is from this premaxillary bone that the upper incisors spring. Now in a certain proportion of cases these premaxillary bones do not become united in man, but remain separated. This is the condition in that repulsive malformation known as hare-lip, from its resemblance to the condition found normally in the hare family. Now does it not seem reasonable to suppose that, if man were a special creation, he would have been created without a premaxillary bone? In view of this defect, while man does possess a marvelously complete apparatus, it is thus far not a *perfect* mouth.

Dr. Bonwill makes the claim that, since the jaw of man is an equilateral triangle, it is the most perfect of mouths. The perfection here must be comparative rather than absolute. It is no more perfect in its way than the jaw and teeth of the serpent, the well developed canines of the Carnivora, and the grinding molars and lateral motion of the jaw of the Herbivora, are in their way. Each is no more perfect for its use than the others

are for theirs. But even within the question of the perfect angle of the human jaw there is something suggestive of evolution, for among the mammals there is every gradation from the long jaw with its acute anterior angle and narrow base to the ampler anterior angle and broader base of the human jaw. There is a constant shortening and recession of the jaw as we approach man, and even in the races of man himself, we see the same gradation, for in the inferior races, such as the Negro and Australian, the lower jaw protrudes farther than does that of the superior races. But even the perfect, equilateral triangular jaw of modern man is being transformed into something different by civilization.

Darwin in the "Descent of Man" remarked that "it appears as if the posterior molar or wisdom-teeth were tending to become rudimentary in the more civilized races of man."

From a careful study of 1,249 skulls, of which 844 were of the highly civilized modern races, 277 of modern inferior races, and 128 were of the Romans, Etruscans, Phœnicians, and other nations of antiquity, Prof. Mantegazza furnishes corroborative evidence of this tendency, for he finds that the wisdom teeth are more frequently absent in the superior than in the inferior types, the percentage of absence being more than twice as great in the former as in the latter. He concludes that at a period more or less remote the third molar will disappear from the human jaw.

It has been also observed that the third molar or wisdom tooth is smaller than the other molars in man, and the same has been found true of the chimpanzee and orang, the apes which most closely approximate man.

In the superior races of man the wisdom teeth frequently remain imperfectly developed beneath the gum, and when they emerge early decay, and they have only two separate fangs, while in some inferior (Melanian) races these teeth are usually sound, and generally have three fangs, thus more nearly approaching the typical mammalian third molar.

This loss of size of the wisdom teeth is due, according to Prof. Schaaffhausen, "to the posterior portion of the jaw being always shortened in the more civilized because they use soft cooked food, and use their jaws less."

So the great law of the equilateral triangle, which Dr. Bonwill has discovered, and ranks beside the immutable law of gravitation, and which he believes impossible save by a special creation, bids fair to be undone by man himself, and to be superseded through civilization by a jaw of greater anterior angle and of broader base.

INSTANCES OF THE EFFECT OF MUSICAL SOUNDS ON ANIMALS.

BY R. E. C. STEARNS.

(Continued from page 130.)

ANOTHER anecdote relating to

PIGEONS AND MUSIC

is recorded by Goodrich.

"Bertoni, a famous instructor in music, while residing in Venice, took a pigeon for his companion, and, being very fond of birds, made a great pet of it. The pigeon, by being constantly in its master's company, obtained so perfect an ear for music that no one who saw his behavior could doubt for a moment the pleasure it took in hearing its master play and sing."

The Rev. Mr. James also furnished us with the following:

"I have a canary of the feminine persuasion who is particularly fond of music. Immediately I begin to play upon the flute she chirps about as if enjoying the music. If I open the cage-door and leave her, she will come as near to me as possible, but not attempt to fly to the music; but if I put her upon my desk, and lay the flute down, she will perch upon the end, and allow me to raise the instrument and play. I often take her into the church and play there upon the organ, and she will perch upon my fingers, notwithstanding the inconvenience of the motion of the hands, and chirp in evident delight at the sweet sounds."